Subj: Selection of Fiber Optic Cable With Thermoset Versus Thermoplastic Outer Jackets

1. Background. Fiber optic cable with a thermoset outer jacket (thermoset jacketed cable) may be selected over that with a thermoplastic outer jacket (thermoplastic jacketed cable) when there is a requirement for a more rugged outer jacket or when greater resistance to high temperature is desired. The ruggedness requirement is more applicable to fiber optic backbone cables that are installed in the main cableways. Thermoplastic-jacketed cables have been damaged during initial installation and later when other cable was pulled in over the already installed thermoplastic jacketed cable. The damaged cable was removed and thermoset jacketed cable successfully installed. The occurrence of thermoplastic jacketed cable damage during initial installations and the uncertainty associated with the installation practices used in later cable installations in the same cableways have lead some users to specify thermoset jacketed cable for the backbone cables. It should be noted that other users have successfully installed thermoplastic jacketed cable through the main cableways.

2. Present recommendations for users specifying thermoset jacketed cable.

a. General. Thermoset jacketed cable should be specified for runs through the main cableways for those users that specify thermoset jacketed cable. Thermoplastic jacketed cable may be used for the cable drops except in the instance when the cable re-enters the cableway.

b. Nonavailability. Substitution of a thermoplastic jaketed cable is at the discretion of the individual Program or user. The only guidance provided is to use thermoplastic jacketed cable instead of unqualified cable. There are presently two sources of supply on the MJL-C-85045 Qualified Products List (QPL). These two sources are qualified for both thermoset jacketed cable and thermoplastic jacketed cable.

3. Early installation case histories (Pre-MIL-C-85045 cable).

a. Newport News Shipbuilding (NNS) had installed approximately 45,000 feet of non-MIL SPEC thermoplastic jacketed cable with negligible cable damage and installation problems.

b. SPAWAR had installed approximately 400,000 feet of non MIL-SPEC thermoplastic jacketed cable with negligible cable damage and installation problems.

e. Ingalls Shipbuilding installed 11 cable runs using non MIL-SPEC thermoplastic jacketed cable and experienced damage to all 11 cables. Ingalls is now using thermoset jacketed cable for all fiber optic installations and problems experienced are insignificant. It should be noted that the non-MIL SPEC thermoplastic jacketed cable installed had a thinner outer jacket than the cables supplied to NNS or SPAWAR. As a result of the Ingalls Shipbuilding problem, the cable manufacturer increased the thickness of the outer cable jacket by 0.25 mm for subsequent installations.

4. NSWCCD-SSES observations.

a. MIL SPEC thermoplastic jacketed cable has been installed on several classes of ships with negligible cable damage and installation problems.

b. Successful installation is dependent upon adequate training to ensure personnel know and follow proper techniques.

(1) Provide initial and refresher training to ensure successful cable installations.

(2) On-site performance evaluation by a QA representative assists in determining areas of weakness and topics to emphasize during fresher training.

(3) Installers performing cable pulls familiar with the proper techniques (see Appendix A, do's and don'ts for cable installations).

(4) Inspection to perform for verifying proper techniques is in appendix B.

*5.* Recommendation.

a. Outer jacket selection for cable should take into consideration:

(1) Training, proficiency and competency of installation personnel performing the cable pull.

(2) Degree that can control the training, proficiency and competency of installation personnel performing future cable pulls on top of cable already run.

(3) Initial cable cost versus cost of re-pulling and replacing damaged cable.

# DO'S & DON'T FOR PULLING CABLE PRACTICES RELATING TO FIBER OPTIC CABLE INSTALLATIONS

Do's & Don'ts For Pulling Cable
Practices Related To Fiber Optic Cable Installations

Do's:

1. Consider safety first for your team and for yourself.
   a. Do wear proper clothing.
   b. Do wear safety equipment (gloves, eye protection, etc.) while pulling cable.
   c. Do verify essential tools are on site (cutters, strippers, ties, flashlight, etc.).
   d. Do use step ladders properly (reposition versus leaning over, position so others can pass, etc.)
   e. Do use caution to keep hands from contacting exposed copper cable conductors (especially power cables) that are in the cable tray while pulling the cable run.
   f. Do use caution to keep hands from contacting armored cable, banding and other sharp objects in the cableways.
2. Plan the entire cable route before pulling the cable.
   a. Do walk the cable route with the entire team, getting everyone's input.
   b. Do measure by frames from fore to aft and by deck files from port to starboard.
   c. Do look for straightest route with least bends and sufficiently open collars.
   d. Do verify that there is sufficient space to pull cable through each collar before pulling the cable.
   e. Do start long cable runs (over 200 ft.) in the middle, then pull the cable run to each end.
3. Do place the cable in a figure 8 instead of a coil after spooling the cable length needed from the cable reel. Note: This will prevent cable from getting tangled (ending up in a rat's nest) while uncoiling during the pull.
4. Do pull cable in a smooth, even manner in rhythm with the other team members.
   a. Do pull the cable as straight as possible.
      Pull straight out, a little at a time, at a tight bend or turn.
   b. Do pull all cable through prior to making a turn or coming to a bend.
      Alternative: Leave a loop at the turn and feed the cable a little at a time.
   c. Do feed cable through at a loop with one hand, then pull more cable to bring the loop back to its original size with the other hand. Perform this "free flowing loop" operation in a steady, synchronous motion.
   d. Do pull cable while another team member behind is feeding slack into the cable run.
   e. Do keep the cable run being pulled on top of the cable fray.
   £ Do stay in a straight line (parallel) to the direction of the other cables in the cable fray while pulling the run.
   g. Do make a gradual transition while crossing tiers in a multiple tier cable tray, if changing tiers is necessary.
   h. Do pull slowlyand carefully, if cannot avoid running the cable along with armored cable.
   i. Do pull slowly enough that it is readily noticed if cable gets caught (Note: This will allow pull to be stopped before cable is damaged).
   j. Do realize that positioning the looped cable over a pipe while feeding will make the cable pull easier.
   k. Do remove debris from collars and the cable route.
   1. Do place excess cable at the end of the cable run in a coil, then locate away from foot traffic.
   m. Do ensure that a cable tag is placed on either side of a bullthead or collar and about *5* feet from each end of the cable nm.
   n. Do use lubricating gel while pulling cable in tight spots.

*5.* Do review these essential cable pulling techniques periodically and when new personnel are present

Do's & Don'ts For Pulling Cable
Practices Related To Fiber Optic Cable Installations
(Continued)

Don'ts:

1. Do not pull cable in the following manner:
   a. Don't jerk on the cable.
   b. Don't pull down on the cable.
      Note: This would usually occur at a bend or at a cableway hanger.
   c. Don't pull on a tight cable.
   d. Don't force a cable inside a bend.
   e. Don't pull the cable too fast
   f. Don't pull the cable too hard;
   g. Don't run the cable through packed (fight) collars (including chaffing rings).
   h. Don't run the cable through tight banding straps that will chaff the cable jacket (leave cable jacket shavings).
   i. Don't run through objects with rough (sharp) edges.
   j. Don't run the cable across (perpendicular to) other cable in a cableway.
   k. Don't pull cable through the bottom of the cableway under existing cable.
   1. Don't step on the cable.
   m. Don't get the cable intertwined with other cable.
   m. Don't wrap the end of the cable into a fist while pulling the cable run.
   n. Don't run cable over pipe or with cable outside of a cableway.
   o. Don't hang excess cable at the end of the cable run so that at one point, the cable is placed in a tight bend.
   p. Don't use any mechanical device (block & tackle, chain fall, etc.) to pull cable.
   q Don't run cable on top of armored cable or PVC jacketed cable (gray jacket) when alternate cable routes are available.

# CRITERIA TO OBSERVE FOR PROPER FIBER OPTIC CABLE PULL

## CRITERIA TO OBSERVE FOR PROPER FIBER OPTIC CABLE PULL

Note: This criteria is for the additional requirements when the cable pulled is fiber optic and not copper. General requirements were not assessed as part of this evaluation.

1. Installation of cables.
   a. Procedure: Observe cable pulls.
   b. Requirement: Fiber optic cables shall be installed by feeding the cable through the cableway in a segment by segment fashion for the entire route and then securing it into the cableways. Block and tackle, chain falls, or other mechanical devices shall not be used to pull fiber optic cable. The cable shall be pulled to avoid kinking, twisting, sharp bending, or stretching by applying excessive pulling force. The fiber optic cable should be monitored at all bend points and at multiple points on long straight runs to ensure that the cable does not encounter sharp objects. It is recommended that the cable be pulled slowly, so that if it does get caught, it will be readily noticeable and cable pulling can be stopped before any damage occurs. Cableways containing armored cable should be avoided where possible. Where installation of fiber optic cables into cableways containing armored cable cannot be avoided, additional personnel shall be used to monitor during pulling due to the increased possibility for mechanical damage to the fiber optic cable.

2. Installed cable slack.
   a. Procedure: Inspect for sufficient installed cable slack.
   b. Requirement: Cables are to be installed in accordance with the following:

      (I) Sufficient slack is to allow for deflection of bulkheads.

      (2) The sag between hangers is to be uniform for each row of cables so that clearance between rows will be the same throughout the cable run.

      (3) Where cables spread out to enter bulkhead stuffing tubes or MCP's, bends is to have a liberal sweep to provide as much flexibility as practicable.

      (4) Cables having only a minimum spread where they pass through bulkhead stuffing tubes are to have enough slack to give them the same flexibility as other cables in the group.

      (5) Cables from equipment are to enter cableways in a curve of sufficient radius to prevent transmission of stresses to the equipment during severe cableway deflection.

      (6) Cables entering or connected to equipment are to have additional slack. Cables terminated in a MIL-C-28876 connector are to have a minimum of 10 inches of slack in the cableway. Cables connected to equipment with resilient or shock mounts are to have a minimum of 18 inches of slack with not less than 3 inches of slack between the equipment and the last point of support loading. Cables inside an interconnection box are to have a minimum of 6 inches of extra cable length to permit 2 connector reterminations.

      (7) Cables crossing expansion joints are to have slack allowance at such points not less than or equal to the maximum movement of the expansion joints.

3. Installed minimum bend diameter.
   a. Procedure: Inspect for compliance with minimum bend diameter requirements.
   b. Requirement: During handling and installation in cableways, cable bends shall not violate the minimum short term bend diameter of 2.63 inch for four fiber cable and 3.63 inch for 8 fiber cable. The completed installation shall not violate the

minimum long term bend diameter of 5.33 inch for 4 fiber cable and 7.25 inch for 8 fiber cable. Special handling procedures are required during installation of cables at or below temperatures of 2 C (36 F). If cable must be installed when its temperature is 2 C (36 F) or lower, that portion of the cable that must be bent during installation shall be warmed thoroughly using a heat gun (or equlvalent) before installing the cable in the cableway.

4. Installed cable retention.
   a. Procedure: Inspect for measures to ensure proper cable retention.
   b. Requirement: Retention of cables on supports can be accomplished by the use of retainers such as contour straps, soft iron flat bars bent over the cables, semi-contour straps or angle-iron retainers. Non toxic strips or channel material shall be used with semi-contour straps, bars, and angle retainers to reduce cable damage, distortion, and chafing. Cable retention is required at every hanger on vertical cable runs. Cable straps are to be omitted on horizontal cable runs except as follows:

      (1) Where the hanger has no side brackets.

      (2) At those locations where the cable runs change direction or pass through beams or bulkheads.

      (3) Where four consecutive hangers woul4 not require straps. In this case, a minimum of one strap shall be installed on every fourth hanger.

      (4) Where the horizontal cable supports have multiple tiers.

5. Inspect for cable damage.
   a. Procedure: Inspect installed cable.
   b. Requirement: The cable is not to have the following type damage: cuts, burnt areas, abrasions, holes, roughened areas, bulges, thin spots, kinks or wrinkles.